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PLASTICITY OF SHALES FROM BRAMPTON BRICK LIMITED

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PLASTICITY OF SHALES FROM BRAMPTON BRICK LIMITED

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ABSTRACT

At the request of Brampton Brick Limited, Brampton, Ontario, samples of brick shales from Brampton and Cheltenham, Ontario, were examined using the Brabender Plastograph. The work was conducted under Mineral Sciences Laboratories Cost Recovery Job No. 025260.

Of the three samples from Brampton, shale #1 (representing standard production material) was found to possess the minimal plasticity commensurate with extrusion of a sound brick column using modern, heavy-duty equipment. Shales #2 and #3 (reported to be difficult to extrude and to crack during drying) produced very low peaks (200 to 300 m.g of torque), indicating poor extrusion for a stiff column and low green strengths. Both responded favourably to additions of bentonite: optimum additions on the order of 1.5 to 2.0% of dry weight are recommended for acceptable results. Neither responded adequately to (overly costly) additions of 1 to 2% of a proprietary additive supplied by the company.

Both shales from Cheltenham showed adequate plasticity for successful extrusion of a stiff, sound brick column.

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INTRODUCTION

At the request of Mr. Anthony Shum, Research and Development, Brampton Brick Limited, the plasticity of five brick shales was investigated using the Brabender Plastograph. When two of the samples were determined to be seriously deficient in plasticity, further tests were requested to determine the influence on their plasticity of additions of bentonite and of a proprietary additive material provided by Mr. Shum.

The work was conducted under Cost Recovery Job 025260, CANMET Project 3.0.2.9.99, Cost Recovery in Mineral Processing.

MATERIALS

The shale samples were received in dried and ground condition, identified as follows:

Brampton Shales;
- #1 - red shale, acceptable plasticity (2.9% moisture)
- #2 - red shale, cracks on drying (1.9% moisture)
- #3 - red shale, cracks on drying (1.9% moisture)

Cheltenham Shales*;
- #4 - red shale (1.0% moisture)
- #5 - green shale (1.0% moisture)

*Shale #4 to be evaluated in mixture of 70:30 red:green ratio.

PROCEDURE

The standard procedure for plastography developed in this Laboratory was employed: 200 g of shale was placed in the mixer, the instrument was operated at "slow" speed while water was added at the rate of 0.5%/min (1 mL/min), determined by long experience to be consistent with the development of the full plasticity inherent in clay materials.

Observation of some of the materials led to the suspicion that they might not be thoroughly dry, i.e., they might have absorbed some moisture from the atmosphere during processing, shipping and storage. Moisture determinations

were made on representative aliquots, approximately 100 g, of each sample, re-dried overnight in a laboratory oven at 105°C. The results are included in the sample descriptions given above, and the plastograms have been adjusted to reflect the original moisture contents of the materials.

RESULTS

The plastograms for the 3 samples from Brampton are given in Fig. 1. The curve for sample #1 shows a configuration typical for several Queenston shales: a moderately sloped rise in consistency to a broad peak reaching a maximum level of 525 metre.grams of torque. Recent experience indicates that, with modern high-powered extruders, this level is just adequate for extrusion of a sound brick column, which is reported to be the case. Shales #2 and #3 show curves approximating those for non-plastic sand, peaking at 230 and 200 m.g of torque respectively, and are completely unsuited to stiff extrusion of a sound column. The Plastograph measures, essentially, resistance to shear of the plasticized mass: at such low bond strength it is not surprising that the bricks crack during drying under load. Brampton Brick Ltd. has reported their successful extrusion only with additions of a plasticizer (Sealbond; a dried and finely ball-milled shale).

Fig. 2 shows the plastograms obtained for the shales from Cheltenham. Sample #5 represents the green shale that occurs in bands and lenses in the deposit. The green Queenston shales are usually sandier than the accompanying red shales and often harder (attributed to higher lime content and hence stronger bonding). The plastogram shows a small sharp peak, reaching 760 m.g of torque, superimposed on a moderately broad peak at about the 700 m.g level: ample height for good extrusion and breadth (plastic range) for good control of consistency over an acceptable range of water content. The sharp, superimposed peak is considered to reflect the presence of fine grained non-clay minerals and/or strongly aggregated clay particles, which display pseudo-plasticity and dilatency. When present in quantity, these non-plastics result in very sharp,

high-rising peaks, which experience has shown can be linked to laminar flow problems and laminations in the bricks. In this case the peak is considered too small to have significant impact. When the green shale is diluted with 70% of the accompanying red shale #4 the plastogram peak is broadened (wider plastic range) and lowered (a sharp peak at 690 m.g on a broad peak reaching 640 m.g). Again, the sharp peak is low-rising, and deemed unlikely to indicate any significant lamination problem.

The effect of bentonite additions to shales #2 and #3 was examined, and is shown in the plastograms of Fig. 3 and 4, using additions of top-quality Wyoming bentonite, "Wyoben". In both cases the effect is marked, giving broad peaks in a well-proportioned configuration considered most desirable for good control of sound stiff extrusion. In both cases an addition of 1.5% bentonite is considered optimum, with peak heights extrapolated to be about 600 m.g of torque, i.e. equal to or better than shale #1.

Also examined was the effect of a proprietary additive supplied by Brampton Brick and reported to be effective at the 1 to 2% level of addition. As shown in Fig. 5 and 6, this material is more effective with shale #2, where 1% raises the peak to an extrudable level of 530 m.g, than with shale #3, where 2% raises the peak to 420 m.g of torque. These results indicate that the additive, unlike bentonite, functions not only through direct addition of plastic fines but also through some reaction, probably superficial, with the shale particles and that shale #3 is less responsive to this treatment than is shale #2.

CONCLUSIONS

1) Brampton shale #1 is acceptably plastic for stiff extrusion using modern high-powered machinery. It would, never the less, benefit from increased production of plastic fines during grinding, which would reduce the probability of internal stresses in the extruded products, as well as the possibility of segregation and plugging behind the die, which is common with shales of minimal plasticity.

2) Brampton shales #2 and #3 are unsuited for satisfactory extrusion: their low shear strength (poor plasticity) is responsible for cracking during drying. They respond favourably to treatment with bentonite and should be capable of sound extrusion with additions of 1.5 to 2.0% of most available sodium bentonites. They are less and unequally responsive to treatment with the additive supplied and its use is not recommended.

3) The 70:30 mixture of Cheltenham red:green shales is adequately plastic for extrusion. Contrary to expectations, the green shale #4 shows a higher consistency than the mixture (and hence the red shale) but has a narrower plastic range.

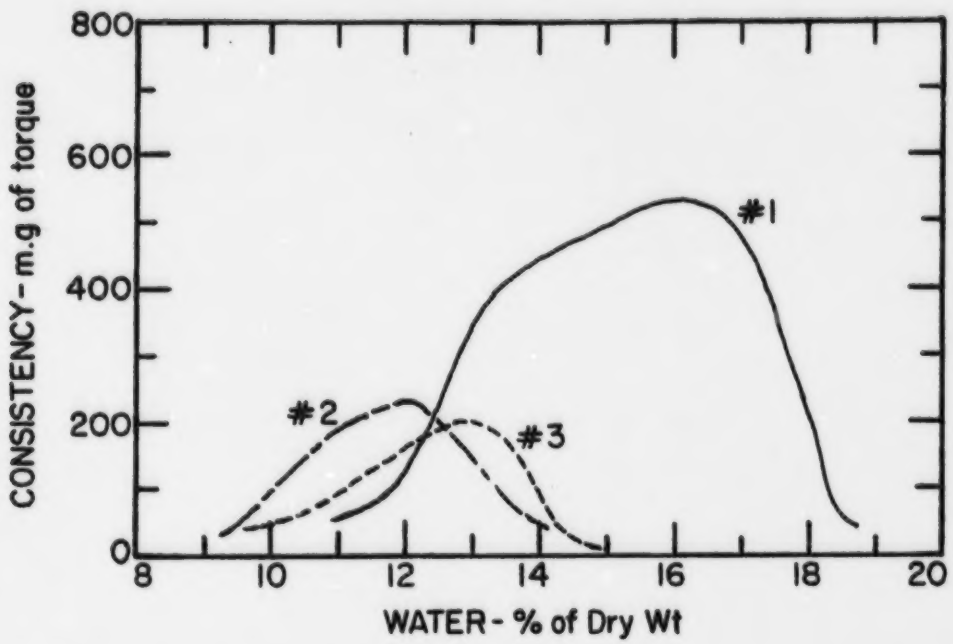

Fig. 1. Plastograms of Brampton shales.

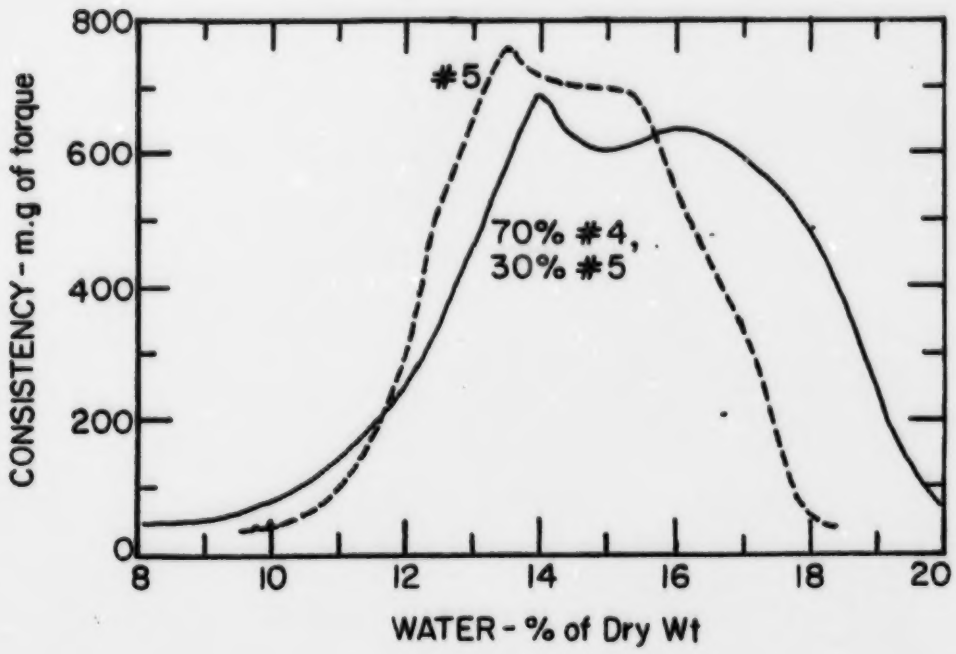

Fig. 2. Plastograms of Cheltenham shales.

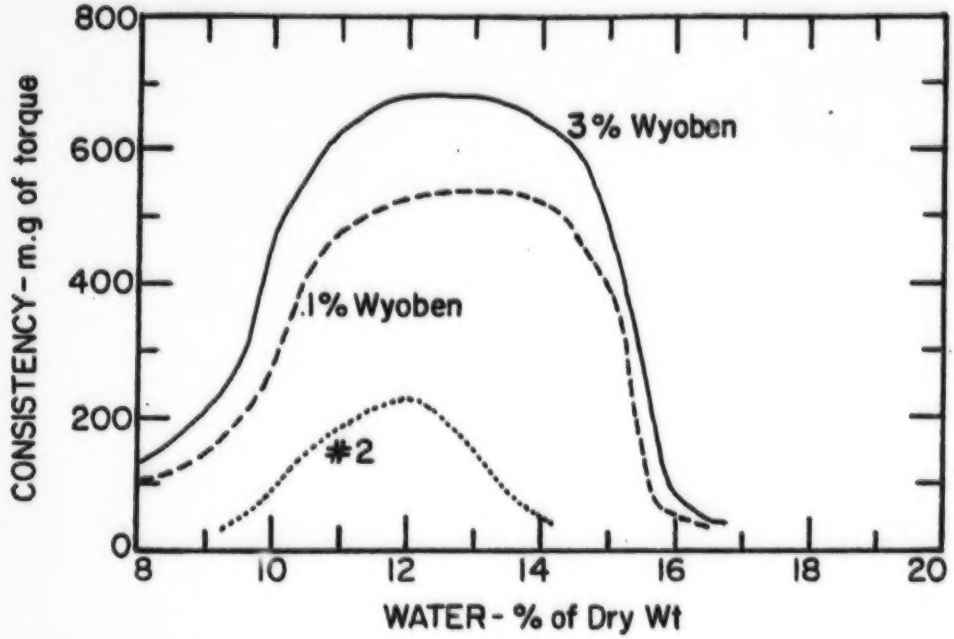

Fig. 3. Influence of bentonite additions on plasticity of Brampton shale #2.

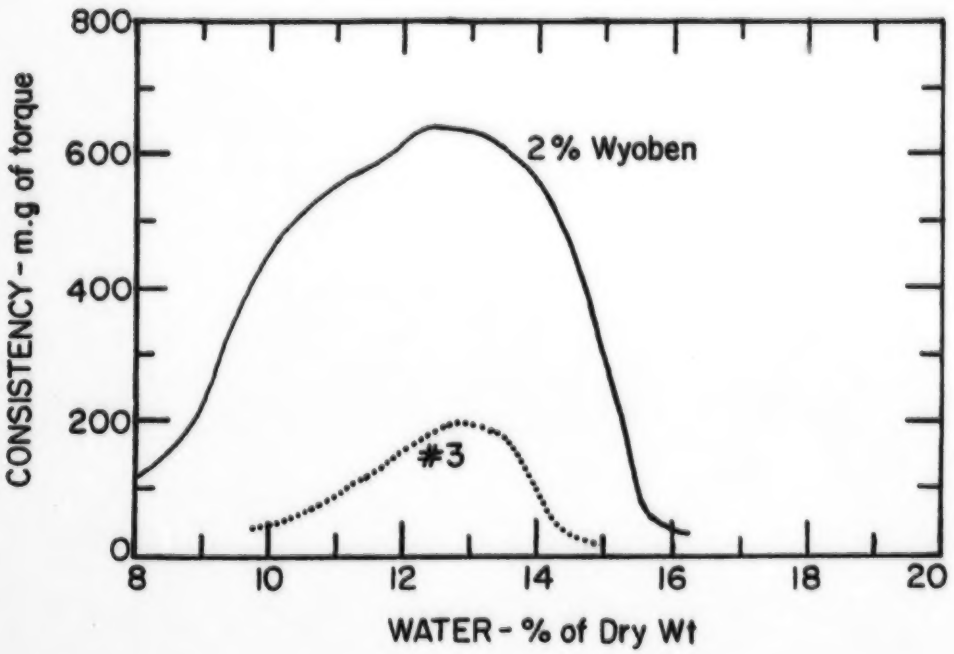

Fig. 4. Influence of bentonite addition on plasticity of Brampton shale #3.

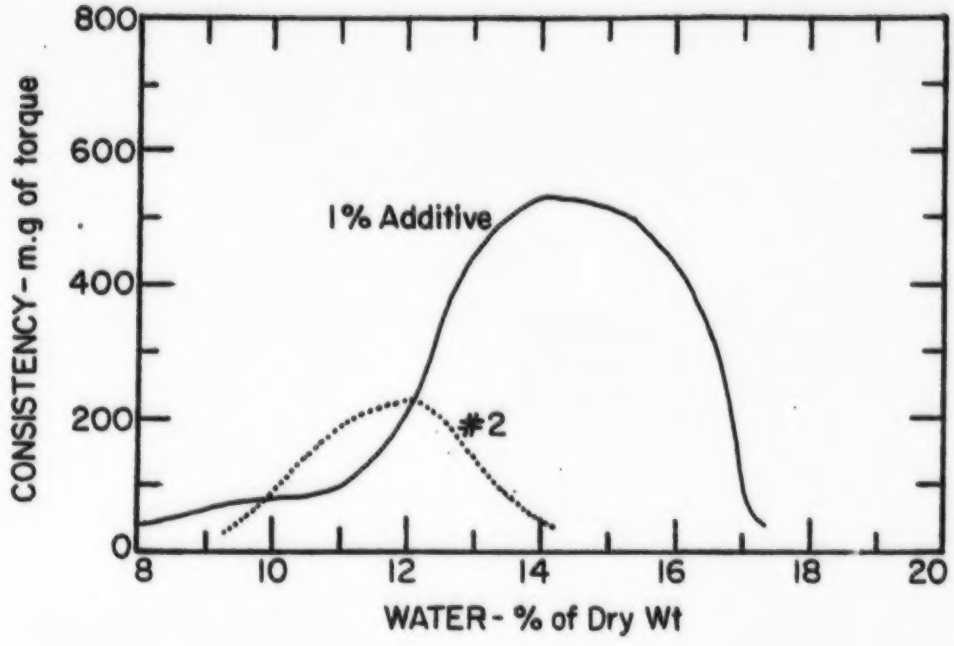

Fig. 5. Effect of proprietary additive on plasticity of Brampton shale #2.

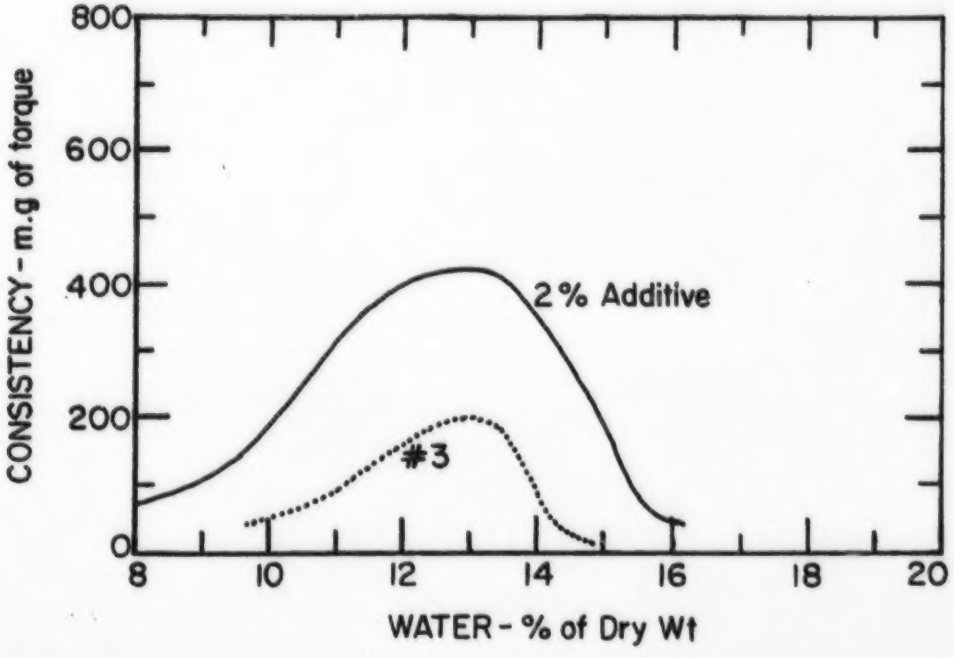

Fig. 6. Effect of proprietary additive on plasticity of Brampton shale #3.